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DEVELOPMENT OF THE MICROSPORANGIA AND MICROSPORES OF ABUTILON THEOPHRASTI

V. LANTIS

(WITH TWELVE FIGURES)

The material used in this study was collected during September and October 1910. While many killing and fixing fluids were tried, Flemming's weaker solution proved the most satisfactory and was therefore the most generally used.

Because of the excessive development of sclerenchymatous tissue in this form, much difficulty was first experienced in sectioning. This was obviated, however, by infiltrating and imbedding in JOHNSTON'S paraffin-asphalt-rubber mixture (**11, 16**), which consists of 99 parts of paraffin (desired grade) in which has been melted enough asphalt (mineral rubber) to give the paraffin an amber color, and one part of crude india rubber. This method, in that it has proved so satisfactory, deserves a more general use among botanists. Many stains were tried, but Heidenheim's iron-alum hematoxylin, with orange G as a contrast stain, gave the best results.

The stamens of *Abutilon Theophrasti* Medic. are epipetalous, monadalphous, and branching. Occasionally the branches of the filaments are so short that the two anthers set back to back, and the two might be taken for one anther in a hasty examination. In longitudinal section the anthers are more or less crescentic in form, while a cross-section shows them to be two-rowed (fig. 5). In this respect it is very much like *Althaea rosea* Cav. (**2, 4**) and *Tilia ulmifolia* (**7**). It is not at all uncommon to see one lobe much longer and more crescentic than the other. The filament is attached to the middle of the inner side of the crescent-shaped anther. Dehiscence takes place by means of one longitudinal fissure.

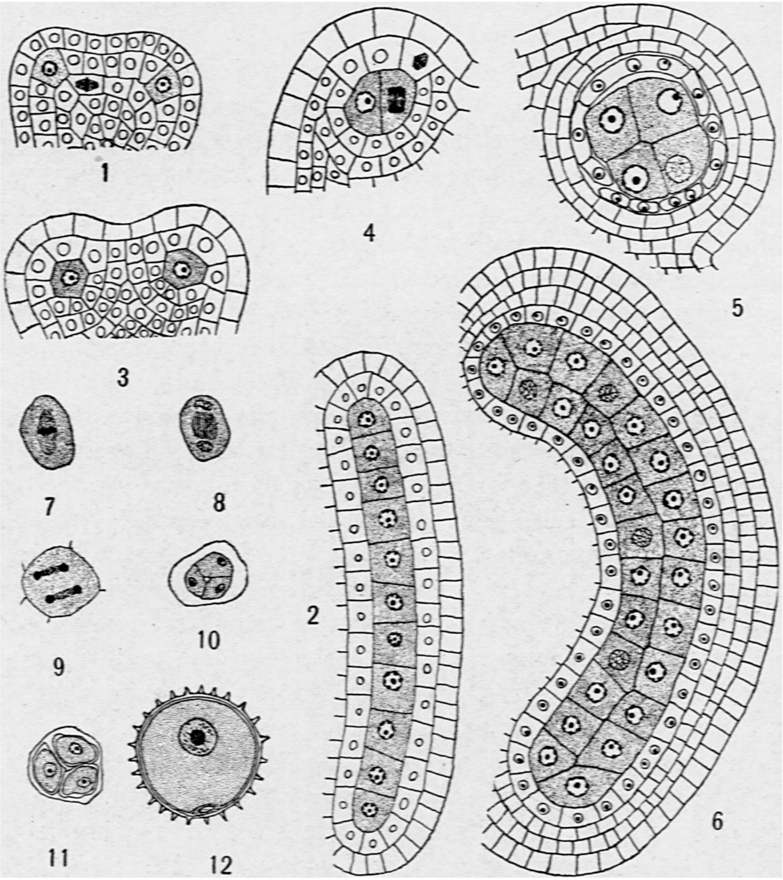
There are two crescent-shaped microsporangia in each anther, one in each of the two lobes. With respect to the number of microsporangia in an anther, *Abutilon* resembles *Althaea* (**2**, **4**), *Hamamelis* (**13**), *Elodea* (**12**), the Asclepiadaceae, etc.

In cross-section the archesporium is a single hypodermal cell (fig. 1). An apparent exception to this was observed in a few cases where two or three hypodermal cells, because of their size and reaction to stains, might be considered archesporial in their possibilities. The subsequent history of the anther, however, shows that there is only one true archesporial cell as seen in cross-section. While a longitudinal section of the archesporium was not observed, it is very evident that it consists of a single row of several cells, since such a section shows the primary parietal and primary sporogenous cells lying in single rows the full length of the anther (fig. 2). This condition in *Abutilon* agrees with that reported for the Malvaceae and most Compositae, and also for *Gaura* (**14**). The archesporial cells divide, as usual, by periclinal walls to form the primary parietal and primary sporogenous cells (fig. 3).

The primary sporogenous cells initiate two successive divisions, one radial and the other periclinal (figs. 4 and 5). Each primary sporogenous cell, therefore, as a rule produces only four mother cells, these four cells being almost regularly shown in a cross-section of the microsporangium (fig. 5). Thus there is quite a contrast between *Abutilon* and *Althaea rosea* (**2**), since in the latter only a single mother cell is usually to be found in a cross-section of the microsporangium, and in *Malva* also the mother cell is reported to develop directly from the primary sporogenous cell.

As may be seen from fig. 4, there are usually two parietal layers in the stage immediately preceding the formation of the mother cells. Fig. 5 shows the spore mother cell just previous to the tetrad formation. At this stage there are three parietal layers including the tapetum, which is well developed. In its origin the tapetum is like that of *Asclepias Cornuti* (**10**), *Silphium* (**9**), and other forms; and the same account is evidently true for *Althaea*, as may be judged from SACHS'S figure (**2**, fig. 377). The tapetum reaches its highest development about the time of the tetrad formation, as is true in most angiosperms. Its development is much later than that of the tapetum of *Euphorbia* (**8**).

At about the time the mother cells are dividing or a little earlier, the nuclei of some of the tapetal cells divide without the formation of cell walls, and tapetal cells with one, two, or three nuclei are found, being much like those described for *Hamamelis* (13), *Ipomoea purpurea* (19), and *Ulmus* (15) in this respect.



FIGS. 1–12.—Fig. 1, cross-section of the anther showing archesporium; fig. 2, primary sporogenous and primary parietal cells in longitudinal section; fig. 3, primary sporogenous cell and plate of parietal cells in cross-section; fig. 4, two daughter cells of primary sporogenous cell in cross-section; fig. 5, cross-section of spore mother cells; fig. 6, longitudinal section of spore mother cells; fig. 7, first division of spore mother cell; fig. 8, two-celled stage of spore mother cell; fig. 9, second division of spore mother cell; fig. 10, tetrad, early stage; fig. 11, later stage of tetrad; fig. 12, mature pollen grain.

The tapetal cells having two or three nuclei are generally more or less elongated (fig. 5).

The spore mother cell is a much prolonged stage, and the second reduction division follows very closely after the first, no walls being formed until after the four nuclei have appeared (figs. 8 and 9), a condition characteristic of the dicotyledons. The tetrad is tetrahedral in arrangement (figs. 10 and 11), no exceptions being observed.

Special study was not made of the composition of the wall of the developing microspores, but evidently it is similar to the microspore walls of *Althaea* (**6**), *Malva* (**5**), and *Ipomoea* (**19**). Since the tapetum reached its highest development during the formation of the tetrad, the mother cells do not become isolated early, but remain intact as in *Althaea* (**1, 2**). While the spore walls are being formed, the tapetum begins to disorganize, but does not entirely disappear until the pollen grains are practically mature. In this respect *Abutilon* resembles *Oenothera* (**17**), *Gaura Lindheimeri* (**14**), etc.

The mature pollen grain is spherical, has both intine and exine well developed, and is covered with spines (fig. 12). Only two nuclei, the tube nucleus and the generative nucleus, were found in the mature pollen grain.

Summary

Abutilon Theophrasti shows the single row of archesporial cells that has been reported for the other two investigated species of Malvaceae, and in the formation of primary parietal and primary sporogenous layers there is also great similarity.

In *Abutilon*, however, each primary sporogenous cell produces four mother cells, while in the other Malvaceae studied only one is formed.

The mother cell stage in *Abutilon* persists until three parietal layers, the inner being a well developed tapetum, are fully formed, after which the characteristic heterotypic and homotypic divisions take place rapidly.

This period of tetrad formation is marked by a multiplication of nuclei in the tapetal cells.

The arrangement of the microspores in the tetrad is tetrahedral and very regular. The tapetum continues to inclose the microspores until they develop their own cell walls and the wall of the mother cell disorganizes, when the tapetal cells gradually disappear. This long persistence of the tapetum is also true of *Althaea rosea*.

The spherical pollen grain of *Abutilon* agrees with that of other described Malvaceae in the number of nuclei and the structure and composition of the walls.

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LITERATURE CITED

1. SCHACHT, H., Die Pflanzenzelle. Berlin. 1852. pp. 58–64. *pls. 6. figs. 14–23.*
2. SACHS, J., Textbook of Botany. English Translation. Oxford. 1882. pp. 546–556.
3. STRASBURGER, E., Über den Bau und das Wachsthum der Zellhäute. 1882. p. 89.
4. GOEBEL, K., Outlines of classification and special morphology. Oxford. 1887. pp. 357–370.
5. STRASBURGER, E., Über das Wachsthum vegetabilischer Zellhäute. Hist. Beiträge. Jena. 1889.
6. MANGIN, L., Observations sur le developpement du pollen. Bull. Soc. Bot. France **36:**391. 1889.
7. KERNER, A., The natural history of plants. English translation. New York. 1895. **2**^{1}:87–88. *figs. 214.*
8. LYON, F. M., Life history of *Euphorbia corollata*. BOT. GAZ. **25:**418–426. *pls. 22–24.* 1898.
9. MERRELL, W. B., A contribution to the life history of *Silphium*. BOT. GAZ. **29:**99–133. *pls. 3–10.* 1900.
10. FRYE, T. C., Development of the pollen in some Asclepiadaceae. BOT. GAZ. **32:**325–331. *pls. 13.* 1901.
11. JOHNSTON, J. B., An imbedding medium for brittle objects. Jour. Appl. Micr. **6:**2662–2663. 1903.

12. Wylie, R. B., The morphology of *Elodea canadensis*. Bot. Gaz. **37**: 1–22. *pls. 1–4*. 1904.
13. Shoemaker, D. M., On the development of *Hamamelis virginiana*. Bot. Gaz. **39**: 248–266. *pls. 6, 7*. 1905.
14. Beer, R., On the development of the pollen grain and anther of some Onagraceae. Beih. Bot. Centralbl. **19**: 286–313. *pls. 3–5*. 1905.
15. Shattuck, C. H., A morphological study of *Ulmus americana*. Bot. Gaz. **40**: 209–223. *pls. 7–9*. 1905.
16. Guyer, M. F., Animal micrology. Chicago. 1906. p. 44.
17. Gates, R. R., Pollen development in hybrids of *Oenothera lata*×*O. Lamarckiana* and its relation to mutation. Bot. Gaz. **43**: 81–116. *pls. 2–4*. 1907.
18. Coulter and Chamberlain, Morphology of angiosperms. New York. 1909.
19. Beer, R., Studies in spore development. Ann. Botany **25**: 199–215. *pls. 13*. 1911.